UNIT 2

The Cell

Chapter 6

A Tour of the Cell

Key Concepts

6.1 **To study cells, biologists use microscopes and the tools of biochemistry**

6.2 **Eukaryotic cells have internal membranes that compartmentalize their functions**

6.3 **The eukaryotic cell's genetic instructions are housed in the nucleus and carried out by the ribosomes**

6.4 **The endomembrane system regulates protein traffic and performs metabolic functions in the cell**

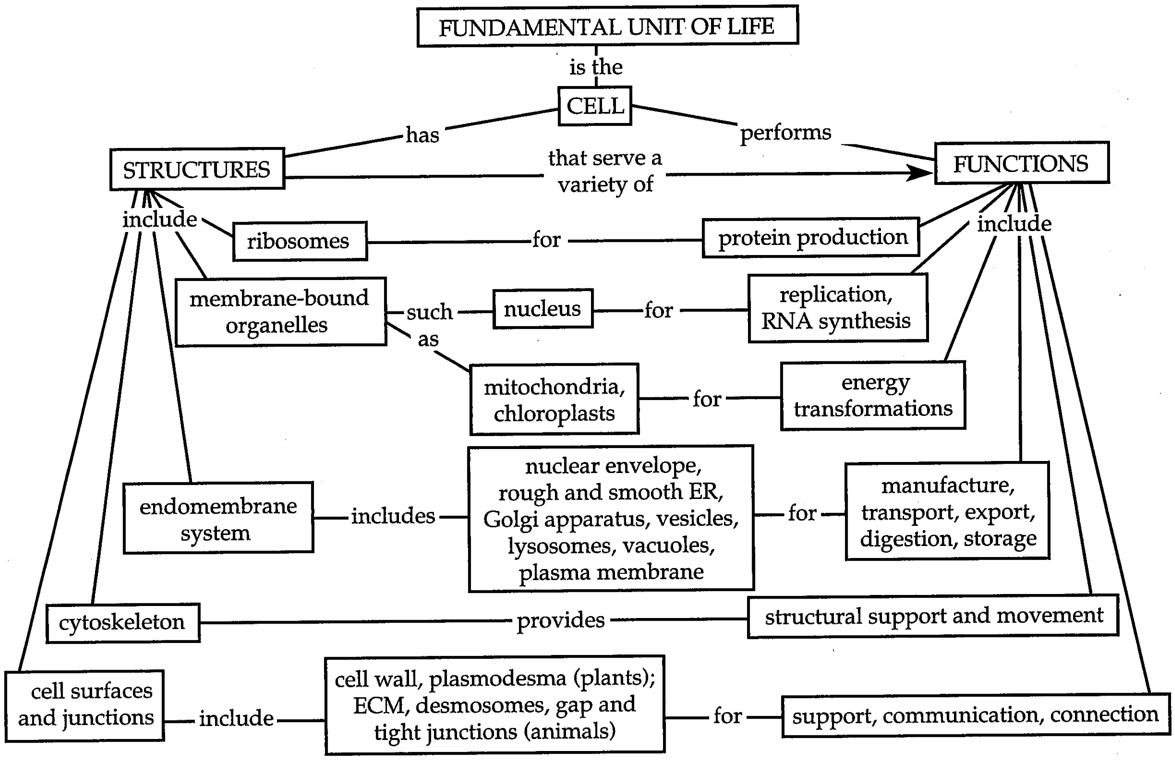
6.5 **Mitochondria and chloroplasts change energy from one form to another**

6.6 **The cytoskeleton is a network of fibers that organizes structures and activities in the cell**

6.7 **Extracellular components and connections between cells help coordinate cellular activities**

Framework

This chapter deals with the fundamental unit of life—the cell. The complexities in the processes of life are reflected in the complexities of the structure of the cell. It is easy to become overwhelmed by the number of new vocabulary terms for this array of cell organelles and membranes. The following concept map provides an organizational framework for the wealth of detail found in "a tour of the cell."



Chapter Review

The cell is the basic structural and functional unit of all living organisms. In the hierarchy of biological organization, the capacity for life emerges from the structural order of the cell. All cells are related through common descent, but evolution has shaped diverse adaptations.

6.1 To study cells, biologists use microscopes and the tools of biochemistry

Microscopy The glass lenses of **light microscopes (LMs)** refract (bend) the visible light passing through a specimen such that the projected image is magnified. *Magnification* is the ratio of this projected image to the real size of the object. *Resolution* is a measure of how clear an image is, and is determined by the minimum distance two points must be separated to be distinguished. The resolution of the light microscope is limited by the shortest wavelength of visible light, so that details finer than 0.2 µm (micrometers = 10^{-3} mm) cannot be resolved. Staining of specimens and using techniques such as fluorescence, phase-contrast, and confocal microscopy improve visibility by increasing contrast between structures that are large enough to be resolved.

Most subcellular structures, or **organelles,** cannot be resolved by the light microscope. Cells were discovered by Robert Hooke in 1665, but their ultrastructure was largely unknown until the development of the **electron microscope (EM)** in the 1950s. The electron microscope focuses a beam of electrons through the specimen. The short wavelength of the electron beam allows a resolution of about 2 nm (nanometers = 10^{-3} µm), a hundred times greater than that of the light microscope.

In a **scanning electron microscope (SEM),** an electron beam scans the surface of a specimen usually coated with a thin gold film, exciting electrons from the specimen, which are detected and translated into an image on a video screen. This image appears three-dimensional.

In a **transmission electron microscope (TEM),** a beam of electrons is passed through a thin section of a specimen stained with atoms of heavy metals, and electromagnets, acting as lenses, focus the image onto a screen or film.

Modern cell biology integrates *cytology* with *biochemistry* to understand relationships between cellular structure and function.

■ INTERACTIVE QUESTION 6.1

a. Define cytology.

b. What do cell biologists use a TEM to study?

c. What does an SEM show best?

d. What advantages does light microscopy have over TEM and SEM?

Isolating Organelles by Cell Fractionation **Cell fractionation** is a technique that separates major organelles of a cell so that they can be identified and their functions can be studied. Cells are homogenized and the resulting cellular soup is separated into component fractions by centrifugation. The homogenate is first spun slowly, and dense structures settle to form a pellet. The supernatant is centrifuged at increasing speeds, each time isolating smaller and smaller cellular components in the pellet. Ultracentrifuges can spin at speeds up to 130,000 rpm.

6.2 Eukaryotic cells have internal membranes that compartmentalize their functions

Comparing Prokaryotic and Eukaryotic Cells All cells are bounded by a plasma membrane, which encloses a semifluid medium called **cytosol.** All cells contain chromosomes and ribosomes. Only members of the domains Bacteria and Archaea have **prokaryotic cells,** which are cells with no nucleus or membrane-enclosed organelles. The DNA of prokaryotic cells is concentrated in a region called the **nucleoid. Eukaryotic cells** have a true nucleus enclosed in a nuclear envelope and numerous organelles suspended in cytosol. **Cytoplasm** refers to the entire region between the nucleus and the plasma membrane, and also to the interior of a prokaryotic cell.

Most bacterial cells range from 1 to 10 μm in diameter, whereas eukaryotic cells are ten times larger, ranging from 10 to 100 μm.

The small size of cells is dictated by geometry and the requirements of metabolism. Area is proportional to the square of linear dimension, while volume is proportional to its cube. The **plasma membrane** surrounding every cell must provide sufficient surface area for exchange of oxygen, nutrients, and wastes relative to the volume of the cell.

■ INTERACTIVE QUESTION 6.2

a. If a eukaryotic cell has a diameter that is 10 times that of a bacterial cell, proportionally how much more surface area would the eukarotic cell have?

b. Proportionally how much more volume would it have?

A Panoramic View of the Eukaryotic Cell Membranes compartmentalize the eukaryotic cell, providing local environments for specific metabolic functions and participating in metabolism through membrane-bound enzymes. Membranes are composed of a bilayer of phospholipid molecules associated with diverse proteins.

6.3 The eukaryotic cell's genetic instructions are housed in the nucleus and carried out by the ribosomes

The Nucleus: Genetic Library of the Cell The **nucleus** is surrounded by the **nuclear envelope,** a double membrane perforated by pores that regulate the movement of large macromolecules between the nucleus and the cytoplasm. The inner membrane is lined by the **nuclear lamina,** a layer of protein filaments that helps to maintain the shape of the nucleus. There is evidence of a framework of fibers, called a nuclear matrix, extending through the nucleus.

Most of the cell's DNA is located in the nucleus, where it is organized into units called **chromosomes,** which are made up of a complex of DNA and proteins called **chromatin.** Each eukaryotic species has a characteristic chromosomal number. Individual chromosomes are visible only when coiled and condensed in a dividing cell.

The **nucleolus,** a dense structure visible in the nondividing nucleus, synthesizes ribosomal RNA and combines it with protein to assemble ribosomal subunits that pass through nuclear pores to the cytoplasm.

■ INTERACTIVE QUESTION 6.3

How does the nucleus control protein synthesis in the cytoplasm?

Ribosomes: Protein Factories in the Cell **Ribosomes** are particles composed of protein and ribosomal RNA. Most of the proteins produced on *free ribosomes* are used within the cytosol. *Bound ribosomes,* attached to the endoplasmic reticulum or nuclear envelope, usually make proteins that will be included within membranes, packaged into organelles, or exported from the cell.

6.4 The endomembrane system regulates protein traffic and performs metabolic functions in the cell

The **endomembrane system** of a cell consists of the nuclear envelope, endoplasmic reticulum, Golgi apparatus, lysosomes, vacuoles, and the plasma membrane. These membranes are all related either through direct contact or by the transfer of membrane segments by membrane-bound sacs called **vesicles.**

The Endoplasmic Reticulum: Biosynthetic Factory The **endoplasmic reticulum (ER)** is the most extensive portion of the endomembrane system. It is continuous with the nuclear envelope and encloses a network of interconnected tubules or compartments called cisternae. Ribosomes are attached to the cytoplasmic surface of **rough ER; smooth ER** lacks ribosomes.

Smooth ER serves diverse functions in different cells: Its enzymes are involved in phospholipid, steroid, and sex hormone synthesis; carbohydrate metabolism; and detoxification of drugs and poisons. Barbiturates, alcohol, and other drugs increase a liver cell's production of smooth ER, thus leading to an increased tolerance (and thus reduced effectiveness) for these and other drugs. Smooth ER also functions in storage and release of calcium ions during muscle contraction.

Proteins intended for secretion are manufactured by membrane-bound ribosomes and then threaded into the lumen of the rough ER, where they fold into their native conformation. Many are covalently bonded to small carbohydrates to form **glycoproteins.** Secretory proteins are transported from the rough ER in membrane-bound **transport vesicles.**

Rough ER manufactures membranes for the cell. Enzymes built into the membrane assemble phospholipids, and membrane proteins formed on bound ribosomes are inserted into the ER membrane. Transport vesicles transfer ER membrane to other parts of the endomembrane system.

The Golgi Apparatus: Shipping and Receiving Center The **Golgi apparatus** consists of a stack of flattened membranous sacs. Vesicles that bud from the ER join to the *cis* face of a Golgi stack, adding to it their contents and membrane. Products that travel through the Golgi apparatus are usually modified or refined as they move from the *cis* region to the *trans* region, perhaps transferred in vesicles from one cisterna to the next. According to the *cisternal maturation model,* Golgi products are processed and tagged as the cisternae themselves progress from the *cis* to the *trans* face. Some polysaccharides, such as pectins, are manufactured by the Golgi of plant cells. Golgi products are sorted into vesicles, which pinch off from the *trans* face of the Golgi apparatus. These vesicles may have surface molecules that help direct them to the plasma membrane or to other organelles.

Lysosomes: Digestive Compartments **Lysosomes** are membrane-enclosed sacs of hydrolytic enzymes used by animal cells to digest macromolecules. Lysosomes provide an acidic pH for these enzymes.

In some protists, lysosomes fuse with food vacuoles to digest material ingested by **phagocytosis.** Macrophages, a type of white blood cell, use lysosomes to destroy ingested bacteria. Lysosomes also recycle a cell's own macromolecules by engulfing damaged organelles or small bits of cytosol, a process known as *autophagy.* During development or metamorphosis, programmed cell death or apoptosis is mediated by lysosomes and helps to create a specific body form.

Vacuoles: Diverse Maintenance Compartments **Food vacuoles** are formed as a result of phagocytosis. **Contractile vacuoles** pump excess water out of freshwater protists. A large **central vacuole** is found in mature plant cells, surrounded by a membrane called the **tonoplast.** This vacuole stores organic compounds and inorganic ions for the cell. Poisonous or unpalatable compounds, which may protect the plant from predators, and dangerous metabolic by-products may also be contained in the vacuole. Plant cells increase in size with a minimal addition of new cytoplasm as their vacuoles absorb water and expand.

The Endomembrane System: A Review As membranes move from the ER to the Golgi and then to other organelles, their compositions, functions, and contents are modified.

■ INTERACTIVE QUESTION 6.4

Name the components of the endomembrane system shown in this diagram and review the functions of each of these membranes.

a.

b.

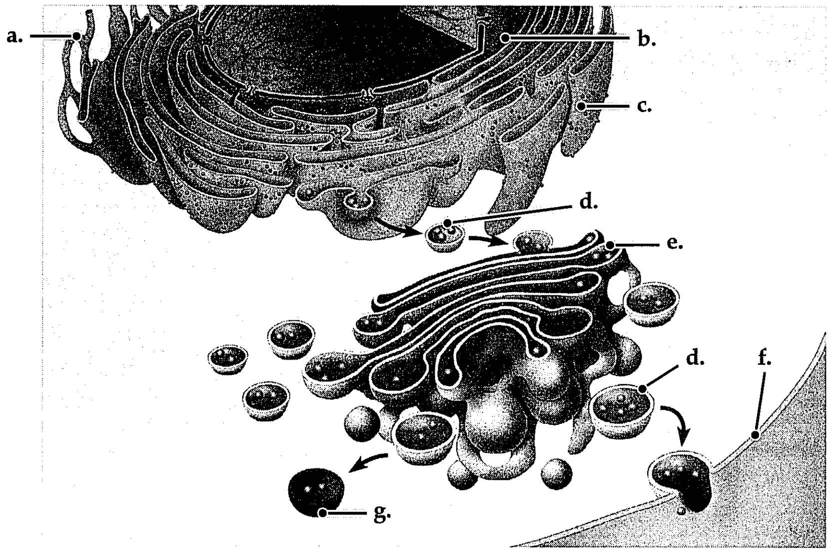
c.

d.

e.

f.

g.



6.5 Mitochondria and chloroplasts change energy from one form to another

Cellular respiration, the metabolic processing of fuels to produce ATP, occurs within the **mitochondria** of eukaryotic cells. Photosynthesis occurs in the **chloroplasts** of plants and algae, which produce organic compounds from carbon dioxide and water by absorbing solar energy. The membrane proteins of mitochondria and chloroplasts are made by ribosomes either free in the cytosol or contained within these organelles. They also contain a small amount of DNA that directs the synthesis of some of their proteins. **Peroxisomes** are oxidative organelles that are also not part of the endomembrane system.

Mitochondria: Chemical Energy Conversion Two membranes, each a phospholipid bilayer with unique embedded proteins, enclose a mitochondrion. A narrow intermembrane space exists between the smooth outer membrane and the convoluted inner membrane. The folds of the inner membrane, called **cristae,** create a large surface area and enclose the **mitochondrial matrix.** Many respiratory enzymes, mitochondrial DNA, and ribosomes are housed in this matrix. Other respiratory enzymes and proteins are built into the inner membrane.

Chloroplasts: Capture of Light Energy **Plastids** are plant organelles that include *amyloplasts,* which store starch; *chromoplasts,* which contain pigments; and *chloroplasts,* which contain the green pigment chlorophyll and function in photosynthesis.

Chloroplasts are bounded by two membranes separated by a thin intermembrane space. Inside the inner membrane is a fluid called the **stroma** surrounding a membranous system of flattened sacs called

thylakoids, inside of which is the thylakoid space. Thylakoids may be stacked together to form structures called **grana.**

■ INTERACTIVE QUESTION 6.5

Sketch a mitochondrion and a chloroplast and label their membranes and compartments.

Peroxisomes: Oxidation Peroxisomes are membrane-enclosed compartments filled with enzymes that function in a variety of metabolic pathways, such as breaking down fatty acids for energy or detoxifying alcohol and other poisons. An enzyme that converts hydrogen peroxide (H_2O_2), a toxic by-product of these pathways, to water is also packaged into peroxisomes.

■ INTERACTIVE QUESTION 6.6

Why are peroxisomes not considered part of the endomembrane system?

6.6 The cytoskeleton is a network of fibers that organizes structures and activities in the cell

Roles of the Cytoskeleton: Support, Motility, and Regulation The **cytoskeleton** is a network of fibers that give mechanical support, function in cell motility (of both internal structures and the cell as a whole), and transmit mechanical signals from the cell's surface to its interior. The cytoskeleton interacts with special proteins called **motor proteins** to produce cellular movements.

Components of the Cytoskeleton The three main types of fibers involved in the cytoskeleton are **microtubules, microfilaments,** and **intermediate filaments.**

All eukaryotic cells have microtubules, which are hollow rods constructed of columns of globular proteins called tubulins. In addition to providing the supporting framework of the cell, microtubules serve as tracks along which organelles move with the aid of motor molecules.

In many cells, microtubules radiate out from a region near the nucleus called a **centrosome.** In animal cells, a pair of **centrioles,** each composed of nine sets of triplet microtubules arranged in a ring, is associated with the centrosome and replicates before cell division.

Cilia and **flagella** are locomotor extensions of some eukaryotic cells. Cilia are numerous and short; flagella occur one or two to a cell and are longer. Many protists use cilia or flagella to move through aqueous media. Cilia or flagella attached to stationary cells of a tissue move fluid past the cell.

Both cilia and flagella are composed of two single microtubules surrounded by a ring of nine doublets of microtubules (a nearly universal "9 + 2" arrangement), all of which are enclosed in an extension of the plasma membrane. A **basal body,** structurally identical to a centriole, anchors the tubules in the cell. ATP drives the sliding of the microtubule doublets past each other as arms, composed of the motor protein **dynein,** alternately attach to adjacent doublets, pull down, release, and reattach. In conjunction with anchoring cross-linking proteins and radial spokes, this action causes the bending of the flagellum or cilium.

Microfilaments, probably present in all eukaryotic cells, are solid rods consisting of a twisted double chain of molecules of the globular protein **actin.** Also called actin filaments, microfilaments function in support, forming a network just inside the plasma membrane and the core of small cytoplasmic extensions called microvilli.

In muscle cells, thousands of actin filaments interdigitate with thicker filaments made of the protein **myosin.** The sliding of actin and myosin filaments past each other causes the contraction of muscles.

Actin and myosin also interact in localized contractions such as cleavage furrows in animal cell division and amoeboid movements. Actin subunits reversibly assemble into microfilaments and then networks, driving the conversion of cytoplasm from sol to gel during the extension and retraction of **pseudopodia.** Actin filaments interacting with myosin may propel cytoplasm forward into pseudopodia. **Cytoplasmic streaming** in plant cells appears to involve both actin–myosin interactions and sol–gel conversions.

Intermediate filaments are intermediate in size between microtubules and microfilaments and are more diverse in their composition. Intermediate fibers appear to be important in maintaining cell shape. The nucleus is securely held in a web of intermediate filaments, and the nuclear lamina lining the inside of the nuclear envelope is composed of intermediate filaments.

■ INTERACTIVE QUESTION 6.7

Fill in the following table to organize what you have learned about the components of the cytoskeleton. You may wish to refer to the textbook for additional details.

Cytoskeleton	Structure and Monomers	Functions
Microtubules	**a.**	**b.**
Microfilaments (actin filaments)	c.	**d.**
Intermediate filaments	e.	**f.**

6.7 Extracellular components and connections between cells help coordinate cellular activities

Cell Walls of Plants Plant **cell walls** are composed of microfibrils of cellulose embedded in a matrix of polysaccharides and protein.

The **primary cell wall** secreted by a young plant cell is relatively thin and flexible. Adjacent cells are glued together by the **middle lamella,** a thin layer of polysaccharides (called pectins). When they stop growing, some cells secrete a thicker and stronger **secondary cell wall** between the plasma membrane and the primary cell wall.

■ INTERACTIVE QUESTION 6.8

Sketch two adjacent plant cells, and show the location of the primary and secondary cell walls and the middle lamella.

The Extracellular Matrix (ECM) of Animal Cells Animal cells secrete an **extracellular matrix (ECM)** composed primarily of glycoproteins. **Collagen,** the most abundant glycoprotein of the ECM, forms strong fibers that are embedded in a network of proteoglycan complexes. **Proteoglycans** consist of a small core protein with many attached carbohydrate chains. Cells may be attached to the ECM by **fibronectins** and other glycoproteins that bind to **integrins,** receptor proteins that span the plasma membrane and bind to microfilaments of the cytoskeleton. Thus, information about changes inside and outside the cell can be exchanged through a mechanical signaling pathway involving fibronectins, integrins, and the microfilaments of the cytoskeleton. Signals from the ECM appear to influence the activity of genes in the nucleus.

Intercellular Junctions **Plasmodesmata** are channels in plant cell walls through which the plasma membranes of bordering cells connect, thus linking most cells of a plant into a living continuum. Water, small solutes, and even some proteins and RNA molecules can move through these channels.

There are three main types of intercellular junctions between animal cells. At **tight junctions,** proteins hold adjacent cell membranes tightly together, creating an impermeable seal across a layer of epithelial cells. **Desmosomes,** reinforced by intermediate filaments, are anchoring junctions between adjacent cells. **Gap junctions** (also called *communicating junctions*) are cytoplasmic connections that allow for the exchange of ions and small molecules between cells through protein-surrounded pores.

■ INTERACTIVE QUESTION 6.9

Return to your sketch of plant cells in Interactive Question 6.8 and draw in a plasmodesma.

The Cell: A Living Unit Greater Than the Sum of Its Parts The compartmentalization and the many specialized organelles typical of cells exemplify the principle that structure correlates with function. The intricate functioning of a living cell emerges from the complex interactions of its multiple parts.

Word Roots

centro- = the center; **-soma** = a body (*centrosome:* material present in the cytoplasm of all eukaryotic cells and important during cell division)

chloro- = green (*chloroplast:* the site of photosynthesis in plants and eukaryotic algae)

cili- = hair (*cilium:* a short hair-like cellular appendage with a microtubule core)

cyto- = cell (*cytosol:* a semifluid medium in a cell in which are located organelles)

-ell = small (*organelle:* a small formed body with a specialized function found in the cytoplasm of eukaryotic cells)

endo- = inner (*endomembrane system:* the system of membranes within a cell that includes the nuclear envelope, endoplasmic reticulum, Golgi apparatus, lysosomes, vacuoles, and the plasma membrane)

eu- = true (*eukaryotic cell:* a cell that has a true nucleus)

extra- = outside (*extracellular matrix:* the substance in which animal tissue cells are embedded)

flagell- = whip (*flagellum:* a long whip-like cellular appendage that moves cells)

glyco- = sweet (*glycoprotein:* a protein covalently bonded to a carbohydrate)

lamin- = sheet/layer (*nuclear lamina:* a netlike array of protein filaments that maintains the shape of the nucleus)

lyso- = loosen (*lysosome:* a membrane-bounded sac of hydrolytic enzymes that a cell uses to digest macromolecules)

micro- = small; **-tubul** = a little pipe (*microtubule:* a hollow rod of tubulin protein in the cytoplasm of almost all eukaryotic cells)

nucle- = nucleus; **-oid** = like (*nucleoid:* the region where the genetic material is concentrated in prokaryotic cells)

phago- = to eat; **-kytos** = vessel (*phagocytosis:* a form of cell eating in which a cell engulfs a smaller organism or food particle)

plasm- = molded; **-desma** = a band or bond (*plasmodesmata:* an open channel in a plant cell wall)

pro- = before; **karyo-** = nucleus (*prokaryotic cell:* a cell that has no nucleus)

pseudo- = false; **-pod** = foot (*pseudopodium:* a cellular extension of amoeboid cells used in moving and feeding)

thylaco- = sac or pouch (*thylakoid:* a series of flattened sacs within chloroplasts)

tono- = stretched; **-plast** = molded (*tonoplast:* the membrane that encloses a large central vacuole in a mature plant cell)

trans- = across; **-port** = a harbor (*transport vesicle:* a membranous compartment used to enclose and transport materials from one part of a cell to another)

ultra- = beyond (*ultracentrifuge:* a machine that spins test tubes at the fastest speeds to separate liquids and particles of different densities)

vacu- = empty (*vacuole:* sac that buds from the ER, Golgi, or plasma membrane)

Structure Your Knowledge

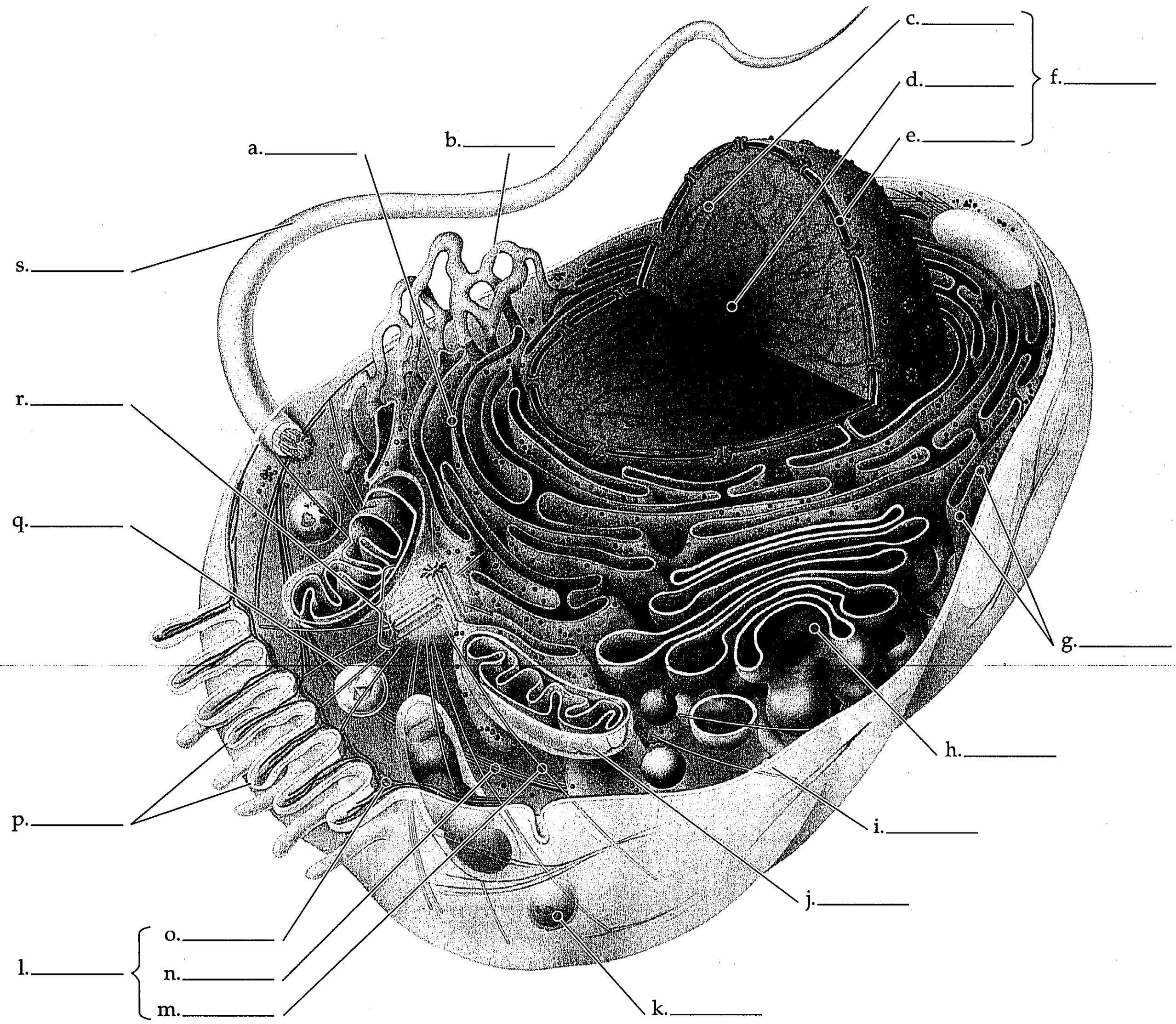
1. The table below lists the general functions performed by an animal cell. List the cellular structures associated with each of these functions.

Functions	Associated Organelles and Structures
Cell division	**a.**
Information storage and transferal	**b.**
Energy conversions	**c.**
Manufacture of membranes and products	**d.**
Lipid synthesis, drug detoxification	**e.**
Digestion, recycling	**f.**
Conversion of H_2O_2 to water	**g.**
Structural integrity	**h.**
Movement	**i.**
Exchange with environment	**j.**
Cell to cell connections	**k.**

2. This table lists structures that are found in plant cells. Fill in the functions of these structures.

Plant Cell Structures	Functions
Cell wall	**a.**
Central vacuole	**b.**
Chloroplast	**c.**
Amyloplast	**d.**
Plasmodesmata	**e.**

3. Label the indicated structures in this diagram of an animal cell.



4. Create a diagram or flow chart in the space below to trace the development of a secretory product (such as a digestive enzyme) from the DNA code to its export from the cell.

Test Your Knowledge

MULTIPLE CHOICE: *Choose the one best answer.*

1. Which of the following is/are not found in a prokaryotic cell?
- **a.** ribosomes
- **b.** plasma membrane
- **c.** mitochondria
- **d.** a and c
- **e.** a, b, and c

2. Resolution of a microscope is
- **a.** the distance between two separate points.
- **b.** the sharpness or clarity of an image.
- **c.** the degree of magnification of an image.
- **d.** the depth of focus on a specimen's surface.
- **e.** the wavelength of light.

3. Which of the following is *not* a similarity among the nucleus, chloroplasts, and mitochondria?
- **a.** They contain DNA.
- **b.** They are bounded by two phospholipid bilayer membranes.
- **c.** They can divide to reproduce themselves.
- **d.** They are derived from the endoplasmic reticulum system.
- **e.** Their membranes are associated with specific proteins.

4. The pores in the nuclear envelope provide for the movement of
- **a.** proteins into the nucleus.
- **b.** ribosomal subunits out of the nucleus.
- **c.** mRNA out of the nucleus.
- **d.** signal molecules into the nucleus.
- **e.** all of the above.

5. The ultrastructure of a chloroplast could be seen with the best resolution using
- **a.** transmission electron microscopy.
- **b.** scanning electron microscopy.
- **c.** phase-contrast light microscopy.
- **d.** cell fractionation.
- **e.** fluorescence microscopy.

6. Which of the following is *incorrectly* paired with its function?
- **a.** peroxisome—contains enzymes that break down H_2O_2
- **b.** nucleolus—produces ribosomal RNA, assembles ribosome subunits
- **c.** Golgi apparatus—processes, tags, and ships cellular products
- **d.** lysosome—food sac formed by phagocytosis
- **e.** ECM (extracellular matrix)—supports and anchors cells, communicates information with inside of cell

7. The cytoskeleton is composed of which type of molecule?
- **a.** protein
- **b.** cellulose
- **c.** chitin
- **d.** phospholipid
- **e.** calcium phosphate

8. A growing plant cell elongates primarily by
- **a.** increasing the number of vacuoles.
- **b.** synthesizing more cytoplasm.
- **c.** taking up water into its central vacuole.
- **d.** synthesizing more cellulose.
- **e.** producing a secondary cell wall.

9. The innermost portion of the cell wall of a plant cell specialized for support is the
- **a.** primary cell wall.
- **b.** secondary cell wall.
- **c.** middle lamella.
- **d.** plasma membrane.
- **e.** plasmodesmata.

10. Contractile elements of muscle cells are
- **a.** intermediate filaments.
- **b.** centrioles.
- **c.** microtubules.
- **d.** actin filaments (microfilaments).
- **e.** fibronectins.

11. Microtubules are components of all of the following *except*
- **a.** centrioles.
- **b.** the spindle apparatus for separating chromosomes in cell division.
- **c.** tracks along which organelles can move using motor molecules.
- **d.** flagella and cilia.
- **e.** the pinching apart of the cytoplasm in animal cell division.

12. Of the following, which is probably the most common route for membrane flow in the endomembrane system?
   a. rough ER → Golgi → lysosomes → nuclear membrane → plasma membrane
   b. rough ER → transport vesicles → Golgi → vesicles → plasma membrane
   c. nuclear envelope → rough ER → Golgi → smooth ER → lysosomes
   d. rough ER → vesicles → Golgi → smooth ER → plasma membrane
   e. smooth ER → vesicles → Golgi → vesicles → peroxisomes

13. Proteins to be used within the cytosol are generally synthesized
   a. by ribosomes bound to rough ER.
   b. by free ribosomes.
   c. by the nucleolus.
   d. within the Golgi apparatus.
   e. by mitochondria and chloroplasts.

14. Plasmodesmata in plant cells are similar in function to
   a. desmosomes.
   b. tight junctions.
   c. gap junctions.
   d. the extracellular matrix.
   e. integrins.

15. In an animal cell fractionation procedure, the first pellet formed would most likely contain
   a. the extracellular matrix.
   b. ribosomes.
   c. mitochondria.
   d. lysosomes.
   e. nuclei.

Use the cells described as follows to answer questions 16–20.
   a. muscle cell in the thigh muscle of a long-distance runner
   b. pancreatic cell that manufactures digestive enzymes
   c. macrophage (white blood cell) that engulfs bacteria
   d. epithelial cell lining digestive tract
   e. ovarian cell that produces estrogen (a steroid hormone)

16. In which cell would you expect to find the most tight junctions?

17. In which cell would you expect to find the most lysosomes?

18. In which cell would you expect to find the most smooth endoplasmic reticulum?

19. In which cell would you expect to find the most bound ribosomes?

20. In which cell would you expect to find the most mitochondria?

FILL IN THE BLANKS *with the appropriate cellular organelle or structure.*

______________ 1. transports membranes and products to various locations

______________ 2. infoldings of the inner mitochondrial membrane with attached enzymes

______________ 3. consists of collagen, proteoglycans, and fibronectins

______________ 4. specialized metabolic compartments with enzymes that transfer hydrogen to oxygen, producing H_2O_2

______________ 5. stacks of flattened sacs inside chloroplasts

______________ 6. anchoring structure for cilia and flagella

______________ 7. semifluid medium between nucleus and plasma membrane

______________ 8. system of fibers that maintains cell shape, anchors organelles

______________ 9. connection between animal cells that creates impermeable layer

______________ 10. membrane surrounding central vacuole of plant cells